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US 4814040 A

(58) Field of Search
UK CL (Edition K) H2E EEKA EPSR EPSX EPX
INT CL^5 H01R , H05K
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(54) Insulation displacement anisotropic electrical connection.

(57) An anisotropic connection between conductive elements (22, 24) having a non-conductive layer (28) is made by an anisotropic adhesive (30) containing conductive particles (32), eg carbon fibres, which penetrate the non-conductive layer. The adhesive may also contain metallic particles (34) which deform to provide further electrical connection.

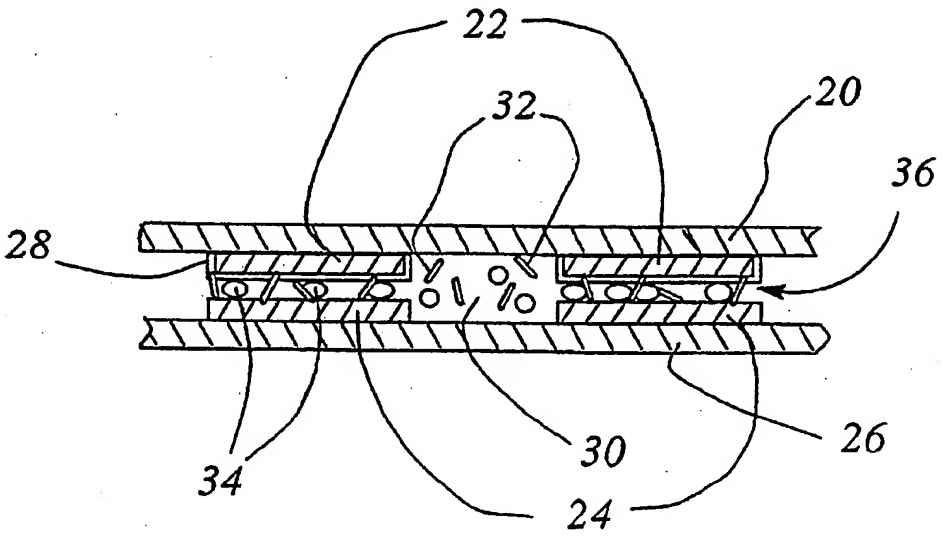

Fig.2.

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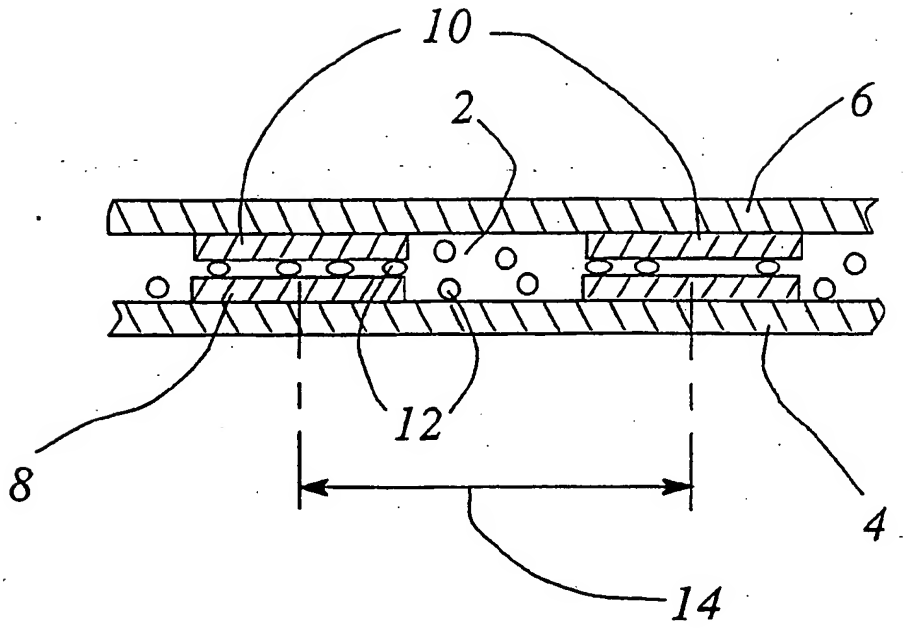


Fig.1.

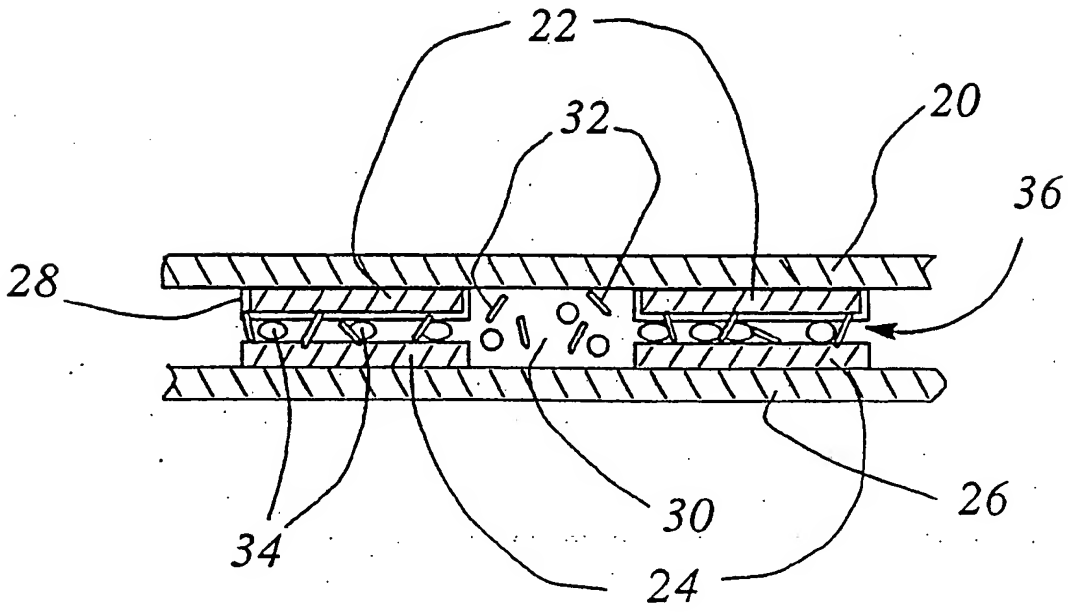


Fig.2.

ANISOTROPIC ELECTRICAL CONNECTION

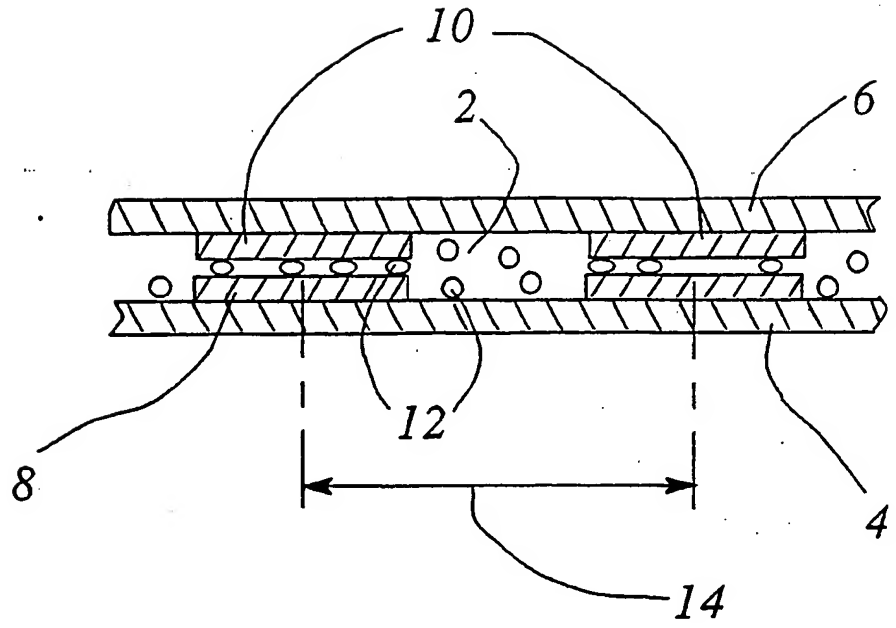
This invention relates to anisotropic electrical connection, and in particular to an adhesive for the anisotropic electrical connection of electrically conductive elements.

More specifically, the invention relates to the electrical interconnection of aligned conductive elements mounted respectively on first and second substrates, without electrical interconnection between adjacent conductors on each substrate.

This is a common requirement, for example, in the production of LCDs or other display panels. In this case, one substrate may be the glass display panel, the electrically conductive elements mounted thereon commonly being formed of a transparent oxide of indium and tin (ITO). The required interconnection is that of the ITO elements to a circuit board for supplying the required driving voltages.

One well established technique for achieving this interconnection is the use of a substrate of thin flexible material in the form of a strip carrying tracks of metal or conductive ink. The strip is bonded to the glass substrate at one end, and to the circuit board at the other end. Alternatively, the circuit board may be incorporated on the strip. Electrical interconnection is achieved by the use of an adhesive which forms an anisotropic connection in bonding. The adhesive comprises an adhesive polymer in which metallic particles are suspended.

This known method of connecting ITO conductors is shown diagrammatically in Figure 1 of the accompanying drawings. The adhesive 2 is sandwiched between the end of the flexible strip 4 and the edge of the glass display panel 6, with the conductive elements 8,10 aligned. Heat and pressure are applied to the joint, such that the metallic particles 12 deform between the aligned conductors 8,10 on the panel 6 and the flexible substrate 4 forming an electrically conductive pathway therebetween. The adhesive is then cured or set by heat to maintain the conductive pathways. Since the metallic particles 12, are small compared to the gap between the conductive elements 8,10 on each substrate 4,6 electrical connection is not



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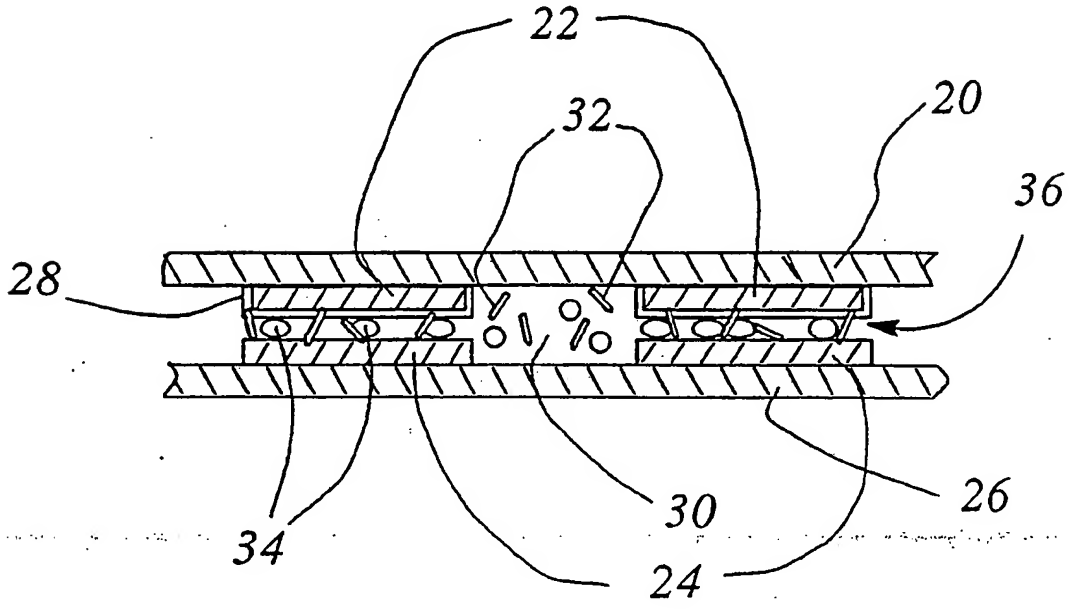

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made between adjacent conductors 8 or 10.

With the fast rate of addressing which is possible with FLCD (ferro-electric liquid crystal display) technology, it is preferable to use low resistive conductive elements or electrodes on the display substrate. This can be achieved by adding a much narrower metal conductor to each ITO element to increase its conductivity, or by replacing the ITO elements with metallic elements where transparancy is not required, for example in printer applications or outside of the active display area.

Aluminium is suitable for this purpose due to its high electrical conductivity. However, connection of aluminium conductors using the method described above has been found to be unreliable. This appears to be due to the non-conductive oxide which forms on the surface of aluminium, the metallic particles merely being squashed when the substrates are pressed together in bonding thus distributing the load over a larger area, and not being capable of fracturing the oxide layer in order to make reliable electrical contact with the conductor.

It is an object of this invention to mitigate this problem.

From one aspect the present invention consists in a method of forming an anisotropic electrical connection between first and second substrates each having a plurality of adjacent conductive elements mounted thereon, at least some of the conductive elements having a non-conductive coating, the method comprising the steps of: aligning the substrates such that at least some of the conductive elements on the first substrate overlie a respective conductive element on the second substrate, and sandwiching between the substrates an insulating adhesive and a plurality of electrically conductive particles, the particles being capable of penetrating the conductive elements having a non-conductive coating by piercing the coating on the application of pressure between the substrates, and applying pressure between the substrates such that the particles and the adhesive form an electrical connection between the overlying elements whilst isolating the adjacent elements from each other.

From another aspect the invention consists in an electrically interconnected assembly comprising first and second substrates each having a plurality of adjacent conductive elements mounted thereon, at least some of the conductive elements having a non-conductive coating, and being aligned such that at least some of the conductive elements on the first substrate each overlie a respective conductive element on the second substrate, and an adhesive bonding the substrates together, the adhesive forming an electrical connection between the overlying elements whilst isolating the adjacent elements from each other, and the adhesive including electrically conductive particles which have pierced the non-conductive coating and penetrated the conductive element.

The elements having a non-conductive coating may be of a metal which forms a stable oxide, for example, aluminium. Particles capable of piercing aluminium oxide have been found to include carbon fibres, disilicides, titanium diboride and tungsten whiskers.

Preferably, the adhesive includes electrically conductive particles which deform when pressure is applied between the substrates, thus making a good electrical connection between the particles penetrating the overlying conductive elements. The deformable particles may be metallic; for example, gold plated nickel. The adhesive base is conveniently a polymer base, or may be, for example, of chemically bonded ceramics such as magnesium-aluminium phosphates.

From yet another aspect, the invention consists in an adhesive comprising a polymer base and carbon fibres.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, which are not to scale, and in which:

Figure 1 is a cross-sectional view of an assembly according to the prior art, as already referred to above; and

Figure 2 is a cross-sectional view of of an assembly according to the invention.

Referring to Figure 2, it is required to connect first

aluminium conductive elements 22 at the edge of a first substrate, which forms a glass display panel 20 of an FLCD screen, to a circuit board for supplying driving voltages. This is achieved by joining the elements 22 to second conductive elements 24, for example, of copper, gold-plated copper, silver or carbon-loaded inks, which are carried by a second substrate 26 in the form of a flexible strip. It is necessary to connect each first element 22 to a respective overlying second element 24 without connecting the adjacent first elements 22 together, or connecting the adjacent second elements 24 together.

An anisotropically electrically conductive adhesive 30, which conveniently is supplied in the form of a film, is sandwiched between the substrate 20,26, and heat and pressure are applied to the joint.

Referring to Figure 2, the adhesive 30, which may comprise a polymer base, includes carbon fibres 32, and metallic particles 34, such as gold coated nickel particles.

The aluminium elements 22,24, on the first substrate 20 have a non-conductive oxide coating 28. When the joint is made, the carbon fibres which are captured in the gaps 36 between respective overlying conductors 22,24, pierce the oxide coating 28 and penetrate the bodies of the aluminium elements 22. The metallic particles, however, are squashed between the elements 22,24.

The particles 32,34 are in sufficient quantity that an electrical connection is made between overlying conductors 22,24, but no such connection is made between adjacent conductors 22 or 24. For instance, in the gap 36 between overlying conductors 22,24 some carbon fibres 32 may penetrate the oxide layers 28 of the first element 22, and also contact the second element 24. Alternatively some fibres 32 which penetrate a first element 22 may contact a metallic particle 34, which contacts the second element 24.

With conductive elements having a pitch of about 1mm, and a depth of about 0.0002mm, carbon fibres having an average length of about 0.05mm have been found to be suitable; for example,

fibres supplied by Courtaulds Grafil Limited as 'Grafil HM-S/0.050 un-sized carbon fibres'.

Whilst one embodiment of the invention has been described, it will be appreciated that modifications may be made without departing from the scope of the invention. For example, the conductive elements may be formed of another material having a stable oxide coating.

CLAIMS

1. A method of forming an anisotropic electrical connection between first and second substrates each having a plurality of adjacent conductive elements mounted thereon, at least some of the conductive elements having a non-conductive coating, the method comprising the steps of: aligning the substrates such that at least some of the conductive elements on the first substrate overlie a respective conductive element on the second substrate, and sandwiching between the substrates an insulating adhesive and a plurality of electrically conductive particles, the particles being capable of penetrating the conductive elements having a non-conductive coating by piercing the coating on the application of pressure between the substrates, and applying pressure between the substrates such that the particle and the adhesive form an electrical connection between the overlying elements whilst isolating the adjacent elements from each other.

2. A method as claimed in claim 1, in which the elements having a non-conductive coating are of a metal which forms a stable oxide coating.

3. A method as claimed in claim 1 or 2, in which the particles capable of piercing the non-conductive coating are carbon fibres.

4. A method as claimed in claim 1, 2 or 3, in which the adhesive includes electrically conductive particles which deform when pressure is applied between the substrates.

5. A method as claimed in any preceding claim, in which deformable particles are metallic.

6. An electrically interconnected assembly comprising first and second substrates each having a plurality of adjacent conductive elements mounted thereon, at least some of the conductive elements having a non-conductive coating, and being

aligned such that at least some of the conductive elements on the first substrate each overlie a respective conductive element on the second substrate, and an adhesive bonding the substrates together, the adhesive forming an electrical connection between the overlying elements whilst isolating the adjacent elements from each other, and the adhesive including electrically conductive particles which have pierced the non-conductive coating and penetrated the conductive element.

7. An adhesive comprising a polymer base and carbon fibres.

8. A method substantially as described herein, with reference to the accompanying drawing.

9. An assembly substantially as described herein, with reference to the accompanying drawing.

10. An adhesive substantially as described herein, with reference to the accompanying drawing.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
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Relevant Technical fields

(i) UK Cl (Edition K) H2E (EEKA,EPSR,EPSX,EPX)

(ii) Int Cl (Edition 5) H01R, H05K

Search Examiner
F J FEE

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search
12 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1-6,8,9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4814040 OZAWA	1,2,6

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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